

Research Article

Major Types of Parahtyroid Glands Location and Their Relationship with the Post-Operative Hypoparathyroidism

Andriy Pasko

Abstract

We have performed 130 operations on the thyroid gland. The spectrum of surgical interventions on the thyroid gland was as follows: hemithyroidectomy was performed for 49.2% of patients, thyroidectomy - for 23.1% of patients and thyroidectomy with central and peripheral lymph node dissection - for 27.7% of patients. All patients were performed the determination of PTG type and their visual assessment.

Types A and B1 are rarely traumatized during operations on thyroid gland, PTG of type B₂ and B₃, C practically in almost all cases are damaged or become ischemic in a varying degree, therefore, types B₂, B₃ and C can be considered as the risk factors for the development of postoperative HPT, and in case of type B₂ of PTG they were technically difficult to be isolated without damage, and in the B₃ and C types it is generally difficult to keep them intact. Determination of the type of PTG and their visual assessment is the basis for solution to the problem of preservation of PTG in place or of their autotransplantation.

Keywords

thyroidectomy; hypoparathyroidism; types of parathyroid glands; autotransplantation

Ivano-Frankivsk National Medical University, Ivano-Frankivsk, Ukraine

Corresponding author: a.y.pasko@ukr.net

Problem statement and analysis of the recent research

Diseases of the thyroid gland (TG) are among the most common and are only the second ones in the structure of endocrine diseases after diabetes mellitus [3]. Moreover, in recent decades, a number of studies have shown an increase of the morbidity of various forms of nodal goiter, as well as thyroid cancer [5]. It should be noted that with the increase of prevalence of TG pathology in recent years, the number of operations increases also, which in turn leads to an increase of postoperative complications [1].

One of the most common specific complications after operations on TG is postoperative hypoparathyroidism (HPT), which occupies a special place in view of the severity of manifestations and the complexity of prevention. Usually, it is due to the trauma or the removal of parathyroid glands (PTG), the violation of their blood supply, and also the development of fibrosis at the site of surgery in the remote terms [2, 6].

One of the main prerequisites for the qualitative (without complications) performance of the TG operation is the visualization of PTG. The most common method of surgical prophylaxis of postoperative HPT is the precision character of surgical manipulations with careful observation of the tactical-technical requirements to the surgeon: to identify TG in time, to mobilize precisely and maintain their blood supply [4, 7]. At the same time, the small size of PTG and their vessels,

the anatomical and embryological peculiarities of localization of these organs, consistency and color similarity with fatty tissue, lymph nodes, often make it impossible to keep them intact structurally and without ischemia. In order to minimize the risk of erroneous removal or damage to the PTG, the surgeon must have modern and thorough knowledge of the anatomy, physiology of these organs, surgical tactics and surgical techniques [3, 9].

The number of PTG is quite variable, although most people have 4 PTG. Under normal circumstances, the preservation of two PTG with good blood supply almost always prevents a permanent HPT after the surgical operation [6, 7]. Even in the successful visualization of PTG, it is not always possible to perform thyroidectomy without their damage. This is due to the peculiarities of the PTG location in relation to TG and peculiarities of their blood supply [5].

In recent years, scientists have identified several types of placement and blood supply to PTG: type A (safe) - PTG does not adhere to the TG with adequate blood supply; type B1 - PTG is attached to the surface of the thyroid capsule, has sufficient blood supply; type B2 - PTG is partially or completely immersed into the TG, but is outside its natural capsule, blood supply is partial from the thyroid gland; type B3 - blood supply is mainly from the thyroid gland, it is difficult to maintain on site, the complete autotransplantation is needed in visual signs of ischemia; type C (type of risk) - the complete attachment to the thyroid gland, fully powered by



Figure 1. The major types of parathyroid glands.

the vascular system from the TG, often coated with a thyroid capsule, after TG examination in vitro an autotransplantation is performed [2].

Therefore, the objective of our work was to identify PTG during operations on the TG, their visual assessment and determination of the type of blood supply, and to analyze the dependence of the incidence of postoperative HPT in different types of PTG.

1. Materials and methods

We have performed 130 operations on the thyroid gland. It is important to note that all the patients at the preoperative stage were examined regarding the exclusion of functional HPT. They were performed the determination of the general and ionized Ca, PTH, and vitamins D3 and Mg. We have included patients without deviations of these indicators from the norm into the study.

All the patients were on in-patient treatment at the surgical department of the Ivano-Frankivsk Central City Clinical Hospital and the Precarpathian Clinical Oncology Center from 2013 to 2017. Among the operated patients, women predominated, they were 94 out of 130 (72.3%; 95% of Fiducial interval (FI) 63.8-79.8%) respectively, men were 36 (27.7%; 95% FI 20.2-36.2 %) Their average age was 51.3 (45.6-59.1) years.

The spectrum of surgical interventions on the thyroid gland was as follows: hemi-thyroidectomy was performed in 64 out of 130 (49.2%; 95% FI 40.4-58.1%) patients, thyroidectomy – in 30 out of 130 (23.1%; 95% FI 16.1-31.3%) patients

and thyroidectomy with central and peripheral lymph node dissection – in 36 out of 130 (27.7%; 95% FI 20.2-36.2%) patients.

All the patients were performed a determination of general and ionized calcium, phosphorus according to the standard methods and ultrasound scanning of the thyroid gland.

To determine PTH, test Biomerica (Biomerica Intact PTH ELISA) was used, which is a solid-phase enzyme-linked immunosorbent assay.

The statistical processing of the obtained results was carried out using the standard program package “Statistica 6.0 for Windows” (StatSoft, USA). The distribution of each of the studied variables was tested “for normality” using the Shapiro-Wilks method. The average arithmetic mean (M) and the mean square deviation (σ) were used to describe the variables with normal distribution. The description of variables, whose distribution differed from normal, was performed using the median (Me) and the lower and upper quartiles (q1 and q3). Estimation of the reliability of the differences between the averages for samples with normal distribution was performed using the Student’s criterion. In comparison of indicators in two independent groups, the distribution of which did not comply with the law of normality, the Mann-Whitney criterion was used. The critical level of significance (p) when checking statistical hypotheses in this study was taken to be 0.05.

2. Results of the research and their discussion

During the performed operative interventions, we could identify an average 3 (3; 4) PTG in a patient.

Table 1. Types of PTG placement identified during thyroid gland operations.

Types of PTG	Abs	% (95 % FI)
A	64	19.1 (15.0-23.7)
B ₁	157	46.9 (41.4-52.4)
B ₂	83	24.8 (20.2-29.8)
B ₃	11	3.3 (1.7-5.8)
C	20	6.0 (3.7-9.1)

Accordingly, we have discovered the following types of PTG location in relation to thyroid gland. The most common type B₁ was found in 157 out of 335 identified PTG (46.9%; 95% FI 41.4-52.4%), the second ones according to the frequency were types B₂ and A respectively in 83 out of 335 (24.8%; 95.5% FI 20.2-29.8%) and in 64 out of 335 (19.1%; 95% FI, 15.0-23.7%) PTG. The type C and B₃ were rarely found accordingly in 20 out of 335 (6.0%; 95% FI 3.7-9.1%) and in 11 out of 335 (3.3%; 95% FI 1.7-5, 8%) PTG.

Among 130 operated patients, the transient postoperative HPT was diagnosed in 56 out of 130 (43.1%, 95% FI 34.4-52.0%) patients, in 12 out of 130 (9.2%; 95% CI 4.9-15.6%) patients it was permanent and in 62 (47.7%, 95% CI 38.9-56.6%) patients signs of HPT were not diagnosed.

Table 2. Frequency of HPT occurrence depending on types of PTG location.

Type of placement	Without signs of HPT (122 PTG)		With transient HPT (172 PTG)		With permanent HPT (41 PTG)	
	Abs	% (95 % FI)	Abs	% (95 % FI)	Abs	% (95 % FI)
A	27	22.1 (15.1-30.5)	33	19.2 (13.6-25.9) $p > 0.05$	4	9.8 (2.7-23.1) $p < 0.001$ $p_1 < 0.001$
B ₁	78	63.9 (54.7 -72.4)	71	41.3 (33.8-49.0) $p < 0.05$	8	19.5 (8.8-34.9) $p < 0.001$ $p_1 < 0.001$
B ₂	16	13.1 (7.7-20.4)	55	32.0 (25.1-39.5) $p < 0.001$	12	29.3 (16.1-45.5) $p < 0.001$ $p_1 > 0.05$
B ₃	1	0.8 (0.0-4.5)	4	2.3 (0.6-5.8) $p > 0.05$	6	14.6 (5.6-29.2) $p < 0.001$ $p_1 < 0.001$
C	0	0.0 (0.0-3.0)	9	5.2 (2.4-9.7) $p < 0.05$	11	26.8 (14.2-42.9) $p < 0.001$ $p_1 < 0.001$

Note.

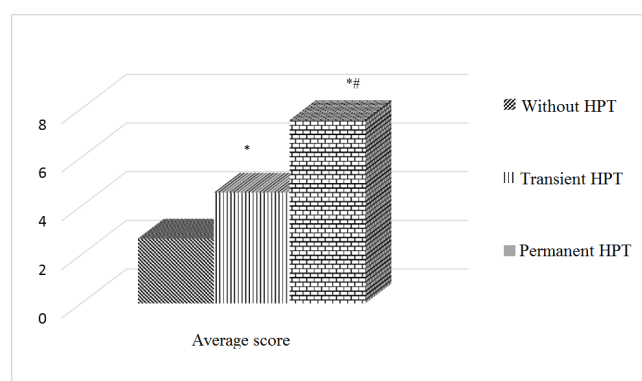
p – the reliability of the difference between patients with transient and permanent HPT in comparison with a group of patients without signs of HPT;

p₁ – the reliability of the difference in the indices of patients with permanent HPT compared with the group of patients without HPT.

Studying the dependence of the onset of HPT on the PTG location, we have found that type A was significantly more common in patients without signs of HPT and its transient form compared with patients with permanent HPT, type B₁ was significantly more common in patients without signs of HPT compared with patients with transient and permanent HPT, and type B₂ was more commonly found in patients with transient and permanent HPT in comparison with patients without HPT, type B₃ and C were most often encountered in patients with permanent HPT.

During surgery, we have also performed a visual evaluation of parathyroid glands and evaluated each gland from 0 to 3 points, according to the degree of its viability damage. So, PTG with unchanged color and unbroken blood supply had 0 points, 1 point - we have evaluated PTG, which somewhat changed the color (it became brown), but with a cut of which there was moderate bleeding, 2 points - a gland that changed its color to a dark brown color, and with the cut of which there is minimal bleeding, and 3 points we gave to the PTG which became dark brown or black and in which there was no bleeding from the place of the incision [8].

We have analyzed the average viability index of PTG according to the postoperative function of PTG. As it can be seen from Fig. 1, the mean score for transient HPT was significantly higher in comparison with the patients without HPT, but the average score in the group with a constant HPT was significantly higher compared with the transient one. Thus, performing a visual assessment of PTG during the operation, we can predict the possibility of further development of post-


Figure 2. Indicators of parathyroid glands viability according to their postoperative function.

Note.

* – the reliability of the difference between transient and permanent HPT in comparison with the group without HPT;

– the reliability of the difference between a group with a constant HPT in comparison with the transient one.

Table 3. The viability of PTG after thyroidectomy, depending on their type.

Types of PTG	Points							
	0		1		2		3	
	Abs	% (95 % FI)	Abs	% (95 % FI)	Abs	% (95 % FI)	Abs	% (95 % FI)
A (n=64)	62	96.9 (89.2; 99.6)	2	3.1 (0.4; 10.8)	0	0.0 (0.0; 5.6)	0	0.0 (0.0; 5.6)
B ₁ (n=157)	145	92.4 (87.0; 96.0) p>0.05	12	7.6 (4.0; 13.0) p>0.05	0	0.0 (0.0; 7.8) p>0.05	0	0.0 (0.0; 7.8) p>0.05
B ₂ (n=83)	0	0.0 (0.0; 4.3) p<0.001 p ₁ <0.001	54	65.1 (53.8; 75.2) p<0.001 p ₁ <0.001	21	25.3 (16.4; 36.0) p<0.001 p ₁ <0.001	8	9.6 (4.3; 18.1) p<0.001 p ₁ <0.001
B ₃ (n=11)	0	0.0 (0.0; 28.5) p<0.001 p ₁ <0.001 p ₂ >0.05	0	0.0 (0.0; 28.5) p<0.001 p ₁ <0.001 p ₂ <0.001	5	45.5 (16.7; 76.6) p<0.001 p ₁ <0.001 p ₂ >0.05	6	54.5 (23.4; 83.3) p<0.001 p ₁ <0.001 p ₂ <0.05

Note.

p – the reliability of the difference between types B₁, B₂ and B₃ compared with type A;

p₁ – the reliability of the difference between types B₂ and B₃ compared with type B₁;

p₂ – the reliability of the difference between type B₃ compared with type B₂.

operative HPT.

We have evaluated the viability of PTG in their different types.

Analyzing the viability of identified PTGs after thyroid gland excision, we have noted that only PTG of type A and B₁ had 0 points, and more than half of the B₂ type glands were assessed as 1 point, 25.3% - 2 points and 9.6% - 3 points, PTG of type B₃ in all cases changed their color and in 45.5% were evaluated as 2 points, and in 54.5% as 3 points, indicating their frequent intraoperative damage.

3. Conclusions

1. Types A and B₁ are rarely traumatized during thyroid gland operations, PTG of type B₂ and B₃, C in almost all cases are damaged or become ischemic in one degree or another, and therefore types B₂, B₃ and C we can consider the risk factors for the development of postoperative HPT, as without their damage it is technically difficult to distinguish them in type B₂ of PTG, but in types B₃ and C it is generally impossible to keep in place.
2. Determination of the PTG type and their visual assessment is the basis for addressing the issue of preservation of PTG in place or their autotransplantation.

References

- [1] Li Y, Jian W, Guo Z et al. A meta-analysis of carbon nanoparticles for identifying lymph nodes and protecting parathyroid glands during surgery. *Otolaryngol Head Neck Surg.* 2015; 152: 1007-1016. DOI: <https://doi.org/10.1177/0194599815580765> [PMid:25897006]
- [2] Cui Q, Li Zh, Kong D et al. A prospective cohort study of novel functional types of parathyroid glands in thyroidectomy in situ preservation or autotransplantation? *Medicine.* 2016; 95: 1-8. DOI: <https://doi.org/10.1097/MD.00000000000005810> [PMid:28033305 PMCID:PMC5207601]
- [3] Lang B, Yih P, Ng K et al. A prospective evaluation of quick intraoperative parathyroid hormone assay at the time of skin closure in predicting clinically relevant hypocalcemia after thyroidectomy. *World J Surg.* 2012; 36(6): 1300-1306. DOI: <https://doi.org/10.1007/s00268-012-1561-9> [PMid:22399155 PMCID:PMC3348470]
- [4] Ji Y, Lee D, Song C et al. Accuracy of intraoperative determination of central node metastasis by the surgeon in papillary thyroid carcinoma. *Otolaryngol Head Neck Surg.* 2014; 150(4): 542-547. DOI: <https://doi.org/10.1177/0194599813519405> [PMid:24429357]
- [5] Bergenfelz A, Jansson S, Kristoffersson A et al. Complications to thyroid surgery: results as reported in a database from a multicenter audit comprising 3,660 patients. *Langenbecks Arch Surg.* 2008; 393: 667-673. DOI: <https://doi.org/10.1007/s00423-008-0366-7> [PMid:18633639]
- [6] Lorente-Poch L, Sancho J, Ruiz S. et al. Importance of in situ preservation of parathyroid glands during total thyroidectomy. *Brit J Surg.* 2015; 102: 359-367. DOI: <https://doi.org/10.1002/bjs.9676> [PMid:25605285]
- [7] Sheahan P, Mehanna R, Basheeth N. et al. Is systematic identification of all four parathyroid glands necessary dur-

ing total thyroidectomy? A prospective study. *Laryngoscope*. 2013. 123(9): 2324-2328. DOI: <https://doi.org/10.1002/lary.23954> [PMid:23733535]

- [8] Ji Y, Song Ch, Sung E. et al. Postoperative Hypoparathyroidism and the Viability of the Parathyroid Glands During Thyroidectomy. *Clinical and Experimental Otorhinolaryngology*. 2016; 13: 1-7.
- [9] Song C, Jung J, Ji M et al. Relationship between hypoparathyroidism and the number of parathyroid glands preserved during thyroidectomy. *World J Surg Oncol*. 2014; 12: 200. DOI: <https://doi.org/10.1186/1477-7819-12-200> [PMid:25000948 PM-Cid:PMC4105163]

Received: 13 Nov 2017

Revised: 8 Dec 2017

Accepted: 11 Dec 2017